**3GPP TSG-RAN WG1 Meeting #32** ***Tdoc R1-030535***
**Paris, France, May 19 – 23, 2003**

**Agenda item:** 5.3 Rel5 CRs

**Source:** Panasonic

**Title:** UE behaviour when UE reaches maximum transmission power with HS-DPCCH

**Document for:** Discussion

# 1. Introduction

In this document, we discuss the behaviour when UE reaches maximum allowed transmission power with HSDPA. We look into current specifications on this behaviour in different WGs. Then, we discuss what points are not specified and propose possible solution. We think transport format combination selection behaviour with HS-DPCCH is not specified clearly. The final CR is probably intended for RAN2 and RAN4 spec.

# 2. Discussion

UE behaviour when UE reaches maximum allowed value consist of short-term behaviour and long-term behaviour. Here we explain short-term behaviour and long-term behaviour very briefly but discussion focus on long-term behaviour. Short-term behaviour is described in TS25.214. Long-term behaviour is called as transport format combination selection (TFC selection) and described in TS25.321 and TS25.133. Although short-term behaviour works to prevent UE transmission power is higher than allowed value, only short-term behaviour does not solve a UL coverage problem, such as high pathloss (UE at the cell border) or big fading dips. Two behaviours can summarize in table 1.

Table 1. Comparison of short-term behaviour and long-term behaviour

| | Short-term behaviour | Long-term behaviour (Transport format combination selection) |
|---|---|---|
| Description | Section 5.1.2.6 of TS25.214 | Section 11.4 of TS25.321<br><br>Section 6.4 of TS25.133 |
| Explanation of the behaviour | When UE detect total UE transmit power (after applying DPCCH power adjustments and gain factors) would exceed the maximum allowed value, this behaviour is processed before transmission in order to ensure not to transmit higher power than allowed value.<br><br>In R99, change of the power is the boundary of DPCCH.<br><br>In Rel 5, change of the power is every slot boundary of DPCCH and every slot boundary of HS-DPCCH. As result, this activation is carried out at twice in a slot. | The UE transmit power estimation for a given TFC is made using the UE transmitted power measured over one slot.<br><br>The UE shall consider the **Elimination criterion** for a given TFC to be detected if the estimated UE transmit power needed for this TFC is greater than the Maximum UE transmitter power for at least 15 out of the last 30 successive measurement periods immediately preceding evaluation.<br><br>The UE shall consider the **Recovery criterion** for a given TFC to be detected if the estimated UE transmit power needed for this TFC has not been greater than the Maximum UE transmitter power for the last 30 successive measurement periods immediately preceding evaluation.<br><br>The evaluation of the Elimination criterion and the Recovery criterion shall be performed at least once per radio frame.<br><br>The UE may remove from the set of valid TFCs, TFCs in Excess-power state in order to maintain the quality of service for sensitive applications (e.g. speech). However, this shall not apply to TFCs included in the minimum set of TFCs |
| Power ratio between DPCCH and DPDCH | Constant after this behaviour | Bit rate over DPDCH is gradually reducing by this process when required transmission power increases. As result, DPCCH has getting higher ratio in total transmission power. |
| Power ratio between DPCCH and HS-DPCCH | Constant after this behaviour | Constant after this behaviour |

On long-term behaviour with HS-DPCCH, we think following points needs to be clarified.
1) The measurement period of UE transmitted power
2) Estimation method of UE transmit power for certain TFC
3) UE behaviour when remaining TFCs are only TFCs included in the minimum set of TFCs [4]

**1) The measurement period of UE transmitted power**

Section 9.1.6 of TS25.133 says the measurement period for UE transmit power is one slot. In R99, we think common understanding is this slot period is aligned with DPCCH slot boundary although we haven't found description. With HS-DPCCH, it is more important to define whether measurement period is DPCCH slot boundary or HS-DPCCH slot boundary to align UE behaviour. Example of the problem is shown in Fig 1. Fig 1 doesn't show short-term behaviour for simplicity of the figure. So transmission power exceeds allowed transmission power in the figure. If the measurement period is aligned with HS-DPCCH, two slots are exceeding allowed transmission power when Ack/Nack transmission is activated. If the measurement period is aligned with DPCCH, depending on the HS-DPCCH/DPCCH power ratio and HS-DPCCH/DPCCH timing offset, from 0 to 4 slots are exceeding allowed transmission power. Our proposal is in order to align R99's common understanding; to clarify that measurement period is aligned with DPCCH slot boundary in TS25.133, which is the specification measurement period is defined.

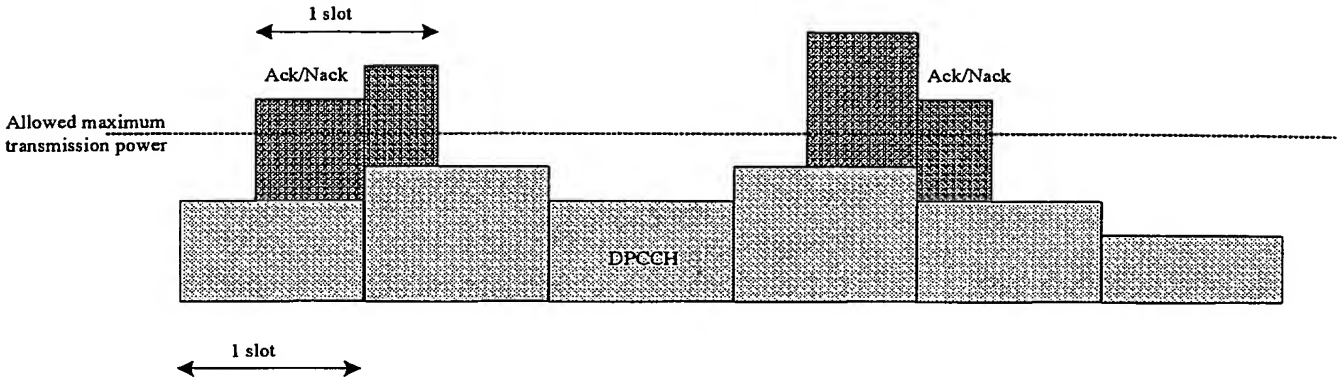


Fig 1. Example of UE transmission power

**2) Estimation method of UE transmit power for certain TFC**

The UE transmit power estimation for a given TFC is made using the UE transmitted power measured over one slot. There could be at least three estimation methods on how HS-DPCCH transmission is taken into account.

Always HS-DPCCH method - When power estimation for a given TFC is made, HS-DPCCH transmission is always assumed to be transmitted although ack/nack or CQI is not transmitted when UE transmitted power is measured. In this method, after long-term behaviour (TFC selection), the power for transmitting HS-DPCCH is always reserved. This method reduces UL coverage of DPDCH transmission to compare with the case of HSDPA is not activated to this UE because of fixed allocation for HS-DPCCH power. Among three methods listed here, this method reduces DPDCH power most. So it looks HS-DPCCH has higher priority than DPDCH.

Never HS-DPCCH method - When power estimation for a given TFC is made, HS-DPCCH transmission is never assumed to be transmitted although ack/nack or CQI is transmitted when UE transmitted power is measured. In this method, after long-term behaviour (TFC selection), the power for transmitting HS-DPCCH is not reserved. This method does not reduce UL coverage of DPDCH transmission to compare with R99 because full power can be allocated for DPDCH when HS-DPCCH transmission is not activated. The obvious demerit is the power for HS-DPCCH is not remaining. Therefore, when Ack or CQI is transmitted, only short-term behaviour works i.e. power ratio between DPCCH/DPDCH/HS-DPCCH is kept. So required power for DPCCH, DPDCH and HS-DPCCH could not be reserved. Among three methods listed here, this method reserves DPDCH power most. So it looks DPDCH has higher priority than HS-DPCCH.

Actual transmission based method - When power estimation for a given TFC is made, the power of HS-DPCCH is based on actual transmission. In this method, the scheduler behaviour and CQI reporting interval impact the UE transmit power estimation. If scheduler assign often for this UE for last 30 successive slots (here, we assumed no modification of the evaluation time), long-term behaviour (TFC selection) reduce the power for DPDCH. If CQI report is configured often, long-term behaviour (TFC selection) reduce the power for DPDCH. For CQI report, this behaviour seems good behaviour because last 30 slots CQI behaviour is expected to be same in future. For Ack/Nack, we are not certain this behaviour is proper because last 30 slots behaviour may be different in future depending on the scheduler algorithm. This method is similar to "always HS-DPCCH method" when allocation is often and CQI is often transmitted. This method is similar to "never HS-DPCCH method" when allocation is not frequent and CQI is not often transmitted.

Above three different methods brings different behaviour of UE. We think it is necessary to specify single behaviour for network operator controls UE behaviour.

The other candidate not listed above is following virtual beta factor method and TFC dependant method. Virtual beta factor method can avoid dependency with the scheduler and long-term behaviour (transport format selection). TFC dependant method has a merit of prioritize some TFCs than HS-DPCCH transmission. We think this modification may be too much for frozen release 5.

Virtual beta factor method - When power estimation for a given TFC is made, Ack/Nack transmission is always assumed to be transmitted like always HS-DPCCH method. The difference is when power estimation of Ack/Nack,

signalled virtual beta factor is used. This virtual beta factor must be smaller value than actual beta factor. This virtual beta factor controls tendency between "always HS-DPCCH method" and "never HS-DPCCH method". If this virtual beta factor and actual beta factor for Ack/Nack is same, this is same as "always HS-DPCCH method". If this virtual beta factor is zero, this is same as "never HS-DPCCH method". For CQI transmission, we think the same as "actual transmission based method" could be fine. This method requires additional RRC signalling as virtual beta factor.

TFC dependant method - When power estimation for some TFCs, the power of HS-DPCCH is based on "always HS-DPCCH method". When power estimation for the other TFCs, the power of HS-DPCCH is based on "never HS-DPCCH method". This method seems complex although this may have gain of some TFCs could prioritize than HS-DPCCH transmission.

Although we don't have strong opinion, we think "actual transmission based method" is one candidate for release 5 from simplicity.

**3) UE behaviour when remaining TFCs are only TFCs included in the minimum set of TFCs**

The minimum set of TFCs is essential for transmission. If UE transmit Ack/Nack or CQI when remaining TFCs are only TFCs included in the minimum set of TFCs, UE cannot ensure to reserve the power for minimum set of TFCs. So we propose to set beta factor for HS-DPCCH is zero in this situation. This is equivalent to not transmitting Ack/Nack or CQI. This could be defined in TS25.321.

**Other remarks on UE behaviour when UE reaches maximum transmission power**

The timing offset of HS-DPCCH and short-term behaviour brings the conclusion that DPCCH power is not constant within one slot. The Node B implementation assuming that DPCCH power is constant within one slot does not work well. In HSDPA, some cells in active set are not R5 Node B. There might be backward compatibility problem depending on R99 Node B implementation.

Node B scheduler doesn't know whether UE reaches maximum power or remaining TFCs are only TFCs included in the minimum set of TFCs. So the scheduler might try to allocate this UE although HARQ-Ack might not transmit reliable transmission. In this case, some downlink radio resource is wasted.

# 3. Conclusion

In this document, we discussed UE behaviour when UE reaches maximum transmission power with HS-DPCCH.

First item is the measurement period of UE transmitted power. We propose to clarify measurement period is aligned with DPCCH slot boundary.

Second item is estimation method of UE transmitting power for certain TFC. We discussed five possible method of power estimation. These are 1) always HS-DPCCH method, 2) always HS-DPCCH method, 3) actual transmission based method, 4) virtual beta factor method and 5) TFC dependant method. One candidate for release 5 could be 3) actual transmission based method although we don't have strong opinion.

Third item is UE behaviour when remaining TFCs are only TFCs included in the minimum set of TFCs. We propose not to transmit HS-DPCCH in this condition to reserve the power for minimum set of TFCs.

# Reference

[1] TS 25.214

[2] TS 25.133

[3] TS 25.321

[4] TS 25.331